"Evaluation of Cardiac Abnormalities in Chronic Kidney Disease."-A Cross Sectional Study.

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Abstract

Background: Chronic kidney disease (CKD) is strongly associated with cardiovascular morbidity and mortality. Cardiorenal interactions lead to structural and functional cardiac abnormalities, including left ventricular hypertrophy (LVH), systolic dysfunction, diastolic dysfunction, arrhythmias, and valvular disease. Early identification of cardiac involvement in CKD is essential to reduce adverse outcomes..

Aim: To evaluate the cardiac abnormalities in patients of chronic kidney disease..

Objective:

- To evaluate cardiac abnormalities in patients with CKD (Stage 3 and above) and determine their patterns using ECG and 2D echocardiography.
    - To document the cardiac abnormalities among patients admitted with chronic kidney disease.
    - To evaluate types of cardiac abnormalities in chronic kidney disease.

Materials and Methods: A cross-sectional study was conducted in the Department of Medicine, Rohilkhand Medical College & Hospital, Bareilly, between August 2023 and December 2024. Seventy-six adult CKD patients (≥18 years) fulfilling inclusion criteria were evaluated. Demographic data, clinical profile, comorbidities, biochemical parameters, ECG, and 2D echocardiography were recorded. Statistical analysis was performed using SPSS v25. A p-value <0.05 was considered significant.

Results

Among 76 patients, males were 56.6% and the most common age group was 35–44 years. Hypertension (55.3%), diabetes (30.3%), and smoking (35.5%) were frequent comorbidities. Proteinuria ≥1+ was present in 84.2%. Mean urea and creatinine levels were 176.9 ± 72.3 mg/dl and 8.7 ± 4.1 mg/dl, respectively.

ECG abnormalities: LVH was the most common (48.7%), followed by poor R-wave progression (6.6%) and ST-elevation (5.3%).

Echocardiographic abnormalities: Diastolic dysfunction (Grade I–III) and LVH were predominant. Cardiorenal syndrome (CRS) type 4 was the most prevalent subtype.

Conclusion:

Cardiac abnormalities are highly prevalent in CKD patients, even before the onset of overt cardiac symptoms. LVH, diastolic dysfunction, and CRS type 4 are the most frequent findings. Routine ECG and echocardiographic evaluation should be incorporated into CKD management for early detection and timely intervention.

Key Wprds: **: Chronic kidney disease, Cardiac abnormalities, Left ventricular hypertrophy, Cardiorenal syndrome, Echocardiography.”**

Introduction

Chronic kidney disease (CKD) is a global public health challenge, with a growing prevalence attributed to the increasing burden of diabetes, hypertension, and aging populations.[1] CKD is characterized by a gradual loss of kidney function over time, often progressing to end-stage renal disease (ESRD), which requires dialysis or kidney transplantation for survival. The prevalence of CKD varies across regions but it affect approximately 10–15% of the global population.[2]CRS generally defined as pathophysiological disorder of the Heart and kidney, whereas acute or chronic dysfunction of one organ may induce acute or chronic dysfunction of the other.[3] The Following are the types according to the duration:

• Type 1 CRS defined as sudden worsening of cardiac function (e.g. acute cardiogenic shock or decompensated congestive cardiac failure) leading to acute kidney injury.

• Type 2 CRS reflects a chronic abnormality in cardiac dysfunction (e.g. chronic congestive failure) lead to progressive chronic kidney disease.

• Type 3 CRS Comprises sudden worsening of renal function (e.g. acute kidney ischemia or glomerulonephritis) causing an acute cardiac dysfunction (arrhythmia, heart failure, ischemia)

• Type 4 CRS is defined as a condition of chronic kidney disease (e.g. chronic glomerular disease) leading to decreased cardiac function, left ventricular hypertrophy and increased risk of adverse cardiovascular events.

• Type 5 CRS nothing but systemic conditions (e.g. sepsis, diabetes, Hypertension, amyloidosis, vasculitis) causing both renal and cardiac dysfunction.[3]In the cardiovascular system, left ventricular hypertrophy (LVH) is the most frequent finding. Doppler derived techniques can generate information regarding ventricular relaxation and its dynamics of filling and emptying, as well as concerning the presence of abnormalities in the cardiac valves like stenosis or regurgitation and the pericardium.[4]

Changes similar to cardiac remodeling like Left Ventricular hypertrophy (LVH) are highly prevalent in Chronic Kidney Disease (CKD) and is associated with unfavorable cardiovascular prognosis; incidence of Left Ventricular Hypertrophy increases with a progressive reduction in renal function.[5] Left Ventricular systolic dysfunction is a strong indicator of poor prognosis in patients on renal replacement therapy.[6] Diastolic dysfunction is characterized by alteration in ventricular relaxation and compliance, mostly followed by a compensatory increase in filling pressure in advanced stages. The later phenomenon is usually responsible for the manifestations of congestive cardiac failure, whatever the immediate cause may be. Small studies have also reported a presence of Left Ventricular diastolic dysfunction in Chronic Kidney Disease (CKD) patients varying from 50-65%, including pre-dialysis, dialysis and post- transplant populations.[7,8]

CKD induces cardiac remodeling through chronic hypertension, volume overload, uremic toxins, RAAS activation, oxidative stress, anemia, metabolic derangements, and vascular calcification. Left ventricular hypertrophy (LVH), diastolic dysfunction, arrhythmias, ischemic heart disease, and heart failure are common complications.

Electrocardiography and 2D echocardiography are simple, non-invasive tools that help detect early cardiac changes. However, limited Indian data exist regarding the prevalence and spectrum of cardiac abnormalities in CKD.

Therefore, this study aimed to evaluate cardiac abnormalities in CKD patients using ECG and echocardiography and to assess the distribution of cardiorenal syndrome (CRS) types.

Materials & Methods

Place of study: The study was conducted among patients attending the Outpatient and Inpatient Departments of Medicine at Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh. Type of study: A cross-sectional study was employed. Duration of study: The study was carried out over a duration of one year, from 18 months August 2023 to December 2024.

Sample size: The calculated sample size is 76.

The sample size was calculated using the formula

N = 4 p q/ $l2$

where:

p = prevalence (2%)5

q=100−p

l= absolute error (5%).

Based on these calculations,

N= 4×2×98 / 25=76. Therefore, the actual sample size determined for the study was 76

participants.

Inclusion Criteria:

Patients aged 18 years and above.

• Patients admitted for the first time with a diagnosis of chronic renal disease.

Exclusion criteria: • Patients with Type 1 diabetes mellitus, gestational diabetes, or secondary diabetes. Page | 30 Material and Methods • Patients with sepsis, amyloidosis, systemic lupus erythematosus (SLE), or vasculitis. • Patients with hypertension. • Patients with cirrhosis. • Patients suspected to have non-diabetic nephropathy, such as those with ultrasonographic findings of contracted kidney or cystic kidney disease. • Patients with other medical illnesses.

METHODOLOGY

: Appropriate permissions were obtained from the Institutional Ethics Committee for the conduction of the study. The study was conducted after receiving written informed consent from all of the patients. Anonymity and confidentiality with respect to the information furnished by the patients were ensured. Laboratory evaluations were performed on 76 patients who underwent routine investigations, including complete hemogram, urine routine tests, and renal function tests. Special emphasis was placed on renal function tests, with all components of the kidney function test (KFT) conducted, along with screening for hepatitis and HIV. Ultrasound abdomen assessments were conducted to evaluate renal size, echotexture, and corticomedullary differentiation. Electrocardiogram (ECG) and 2D echocardiography (ECHO) were performed to diagnose heart failure, classifying patients into those with reduced ejection fraction (40%). Diastolic dysfunction was graded using tissue and pulse Doppler techniques.

STATISTICAL ANALYSIS

SPSS v25 was used. Results presented as mean ± SD and percentages. Chi-square test and t-test used where applicable. Significance: $p < 0.05$.

Results: . Distribution of study participants according to their age (n=76)

The study included 76 participants, with their ages distributed across five groups. The largest age group was 35-44 years, comprising 25% of the participants, followed by 4554 years (23.7%), and <35 years and 65-74 years, each representing 18.4%. The smallest group was 55-64 years, accounting for 14.5%.

. Distribution of study participants according to their sex (n=76)

Sex	**Frequency**	**Percentage**
Female	33	43.4
Male	43	56.6
Total	76	100

Of the 76 participants, 56.6% were male, while 43.4% were female.

. Distribution of study participants according to their comorbidity status

(n=76)

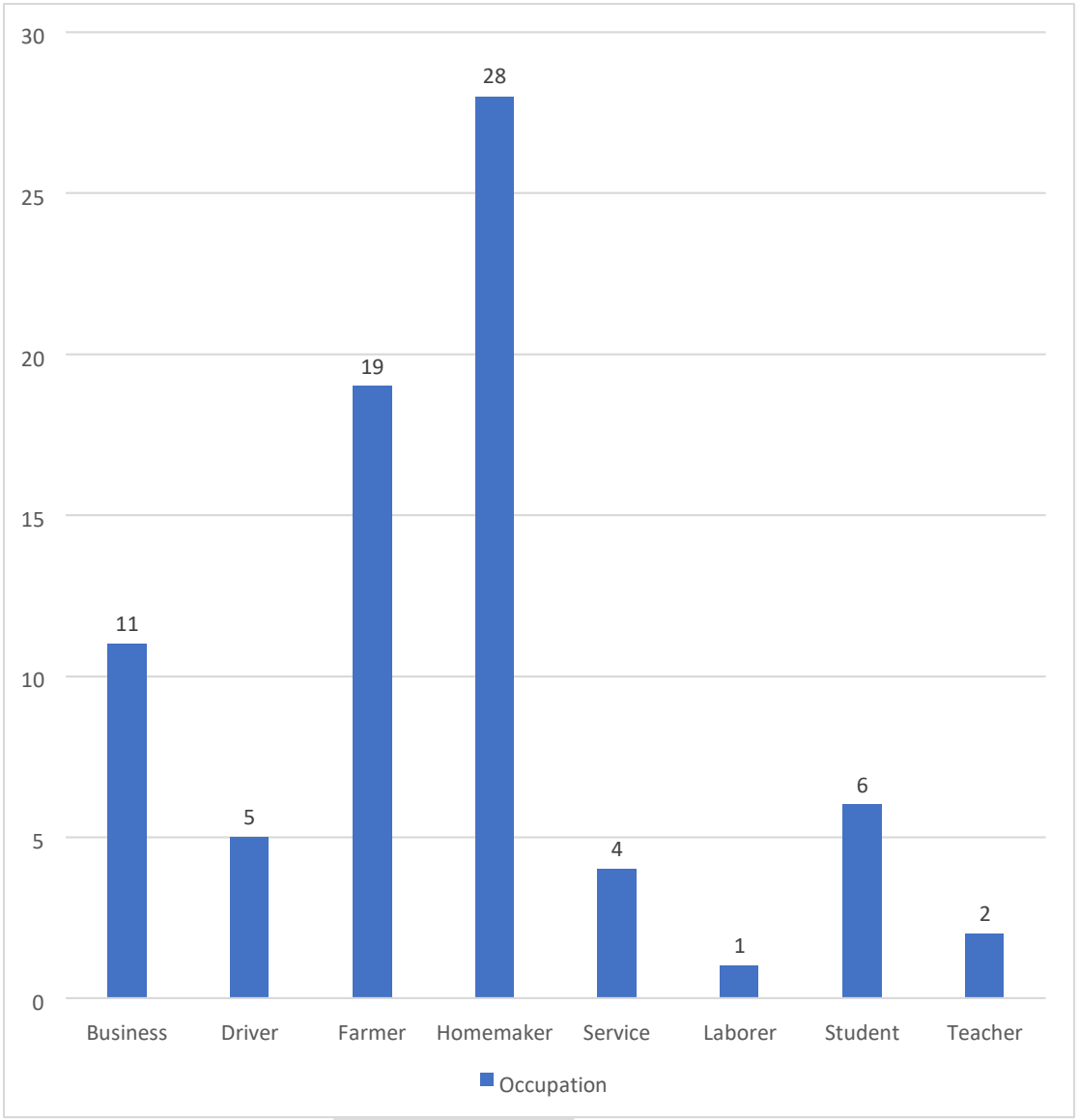
Comorbidity status*	**Frequency**	**Percentage**
Hypertension	42	55.3

Diabetes	23	30.3
Hypercholesterolemia	13	17.1
Smoking	27	35.5
Obesity	12	15.8
Previous history of MI	4	53.
Previous renal insufficiency	9	11.8

*Multiple comorbidities possible in a single patient

On observing the comorbidities hypertension was the most prevalent comorbidity, affecting 55.3% of participants. Diabetes was observed in 30.3%, followed by smoking (35.5%) and hypercholesterolemia (17.1%). Obesity was present in 15.8%, while previous myocardial infarction (5.3%) and renal insufficiency (11.8%) were less frequent. Multiple comorbidities were common.

Distribution of study participants according to their occupation (n=76) Table 5.



Distribution of study participants according to their presenting complaints (n=76)

Presenting complaints*	**Frequency**	**Percentage**
Shortness of breath	55	72.4
Decreased urine output	27	35.5
Fever	9	11.8

Pedal edema	22	28.9
Anasarca	16	21.1
Vomiting	20	26.3

Distribution of study participants according to their ECG findings

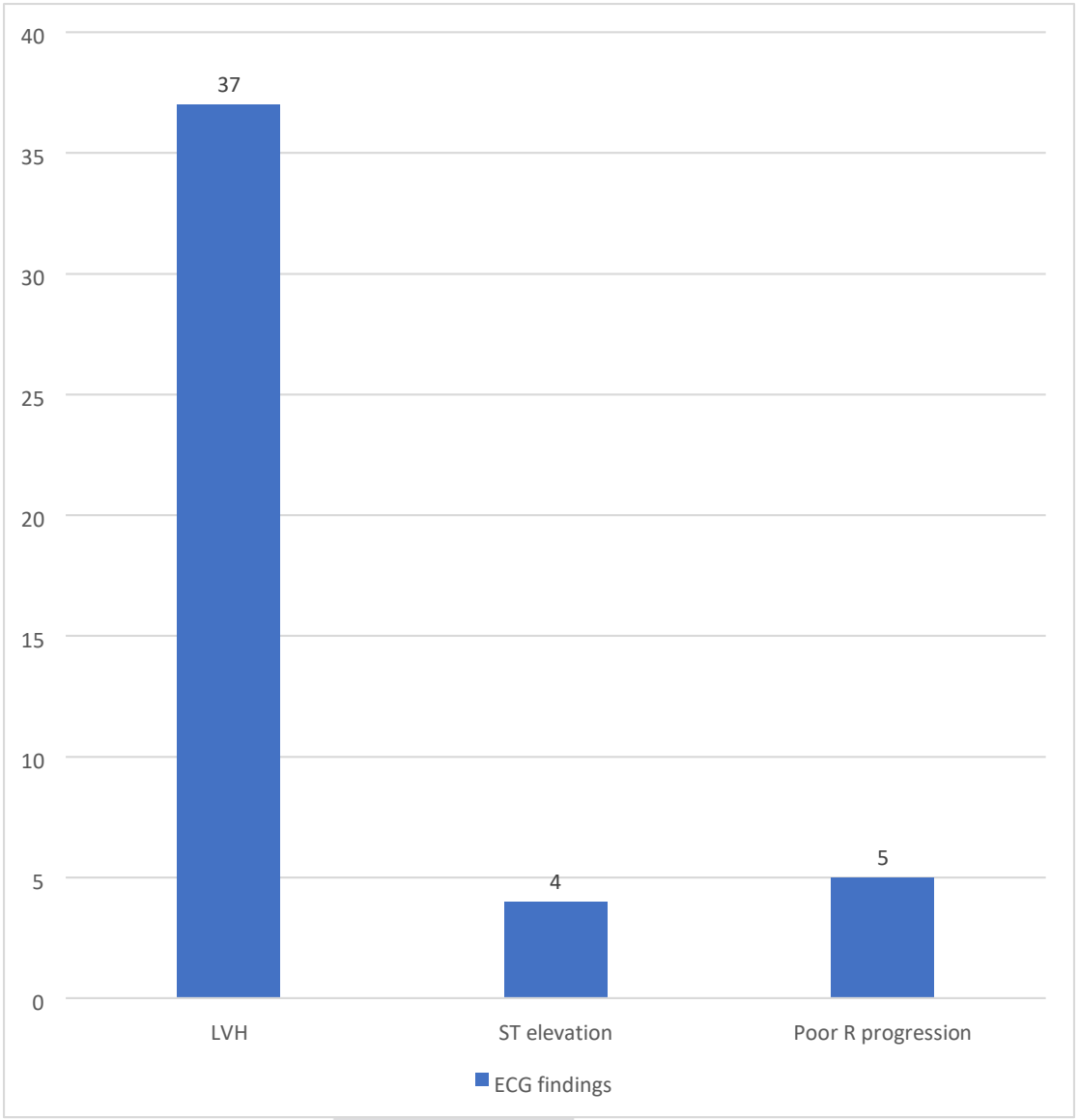
(n=76)

ECG findings*	**Frequency**	**Percentage**
LVH	37	48.7
ST elevation	4	5.3
Poor R progression	5	6.6

*Multiple adverse findings possible in a single patient

On evaluation, ECG findings revealed left ventricular hypertrophy (48.7%) as the most common abnormality. ST elevation and poor R progression were noted in 5.3% and 6.6% of participants, respectively. Multiple abnormalities were observed in some cases.

Figure 10. Distribution of study participants according to their ECG findings



(n=76)

Table 11. Distribution of study participants according to their 2D echocardiography findings (n=76)

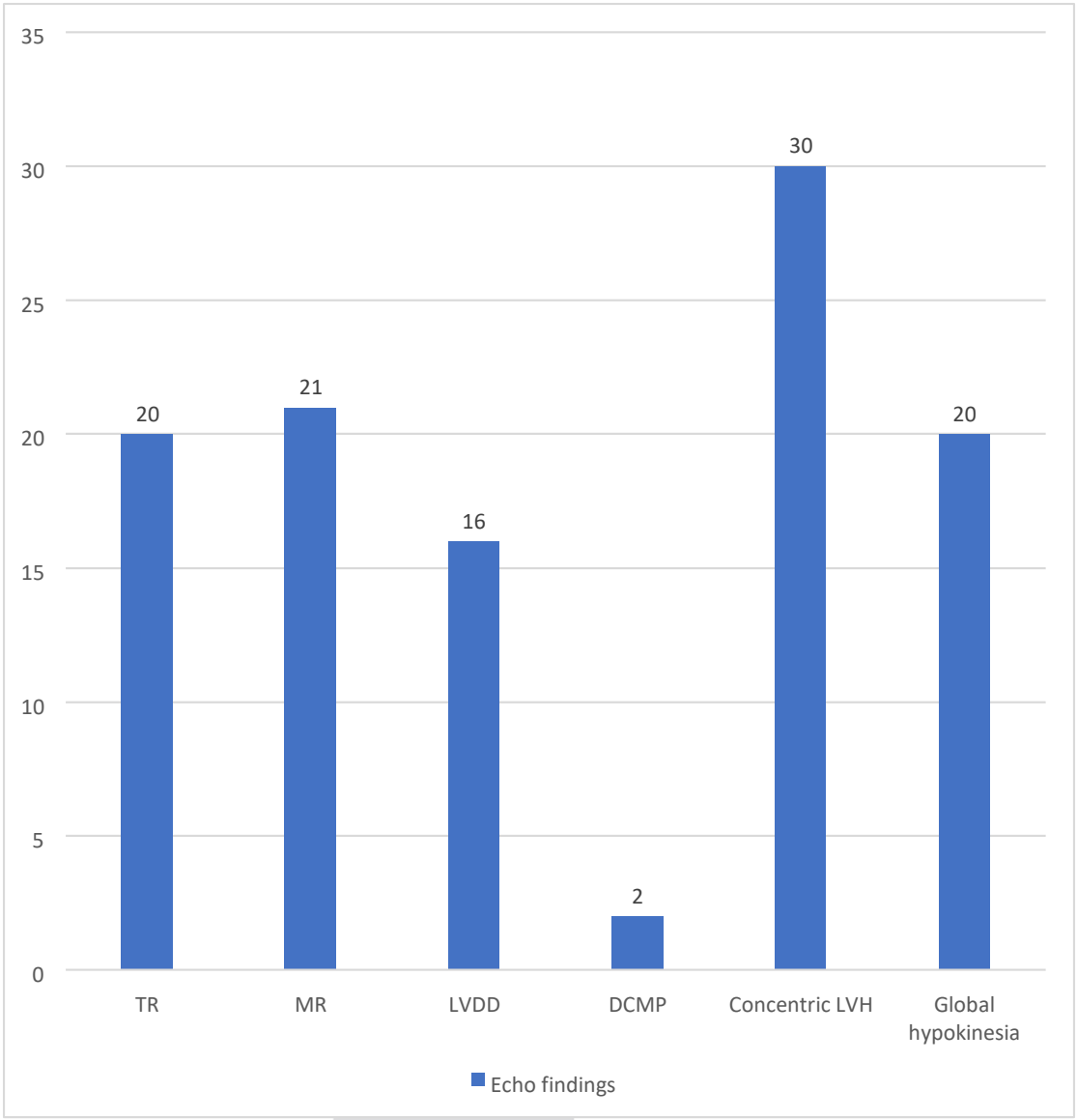
Echo findings*	Frequency/ mean	Percentage/ SD
TR	20	26.3
MR	21	27.6

LVDD	16	21.1
DCMP	2	2.6
Concentric LVH	30	39.5
Global hypokinesia	20	26.3
Mean LVEF (%)	47.4	13.6

*Multiple adverse findings possible in a single patient

Echocardiography findings included concentric LVH in 39.5% of participants and mitral regurgitation in 27.6%. Tricuspid regurgitation and global hypokinesia were each observed in 26.3%. The mean left ventricular ejection fraction was 47.4% ± 13.6%, reflecting varied cardiac function.

Figure 11. Distribution of study participants according to their 2D echocardiography findings (n=76)



Cardiorenal Syndrome (CRS)

CRS Type 4 (CKD leading to cardiac dysfunction) was the most prevalent.

CRS Type 1, 2, and 5 were less common.

Discussion

This study demonstrates a high prevalence of cardiac abnormalities in CKD patients, supporting existing evidence that CKD is a major cardiovascular risk state.

LVH was the most common abnormality, consistent with prior Indian studies where prevalence ranged from 60–75%. Mechanisms include chronic pressure overload, RAAS activation, and anemia.

Diastolic dysfunction was frequently observed, attributed to myocardial fibrosis, LV stiffness, and hypertension. This aligns with prior studies showing diastolic dysfunction in 50–65% of CKD patients.

Proteinuria and elevated creatinine levels in our patients reflect advanced renal dysfunction, strongly associated with structural cardiac changes.

CRS Type 4 predominance emphasizes the chronic impact of CKD on cardiac physiology. Recognition of CRS subtypes is essential for optimizing treatment strategies.

The high prevalence of ECG abnormalities (especially LVH) underscores the utility of routine ECG screening.

Overall, this study reaffirms the bidirectional relationship between kidney and heart diseases and stresses the importance of early detection.

Conclusion

Cardiac abnormalities are highly prevalent among CKD patients, with LVH, diastolic dysfunction, and CRS Type 4 being the most common. Routine ECG and echocardiographic assessment should be integrated into CKD management to identify early cardiovascular involvement and reduce morbidity and mortality.

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